Jun 25th, 11:00 AM - 11:20 AM

# Concurrent Sessions B: Lamprey Passage - Fishway Passage Bottlenecks And Prioritization Planning: A Pacific Lamprey Case Study

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# Fishway passage bottlenecks and prioritization planning: a Pacific lamprey case study

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# Acknowledgements


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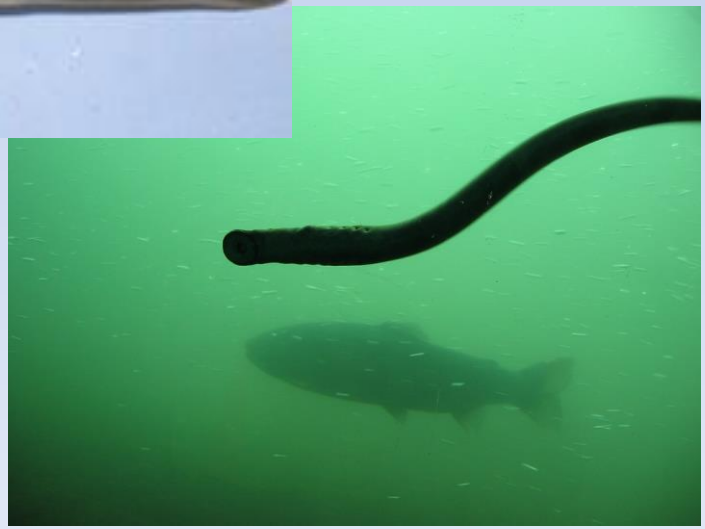
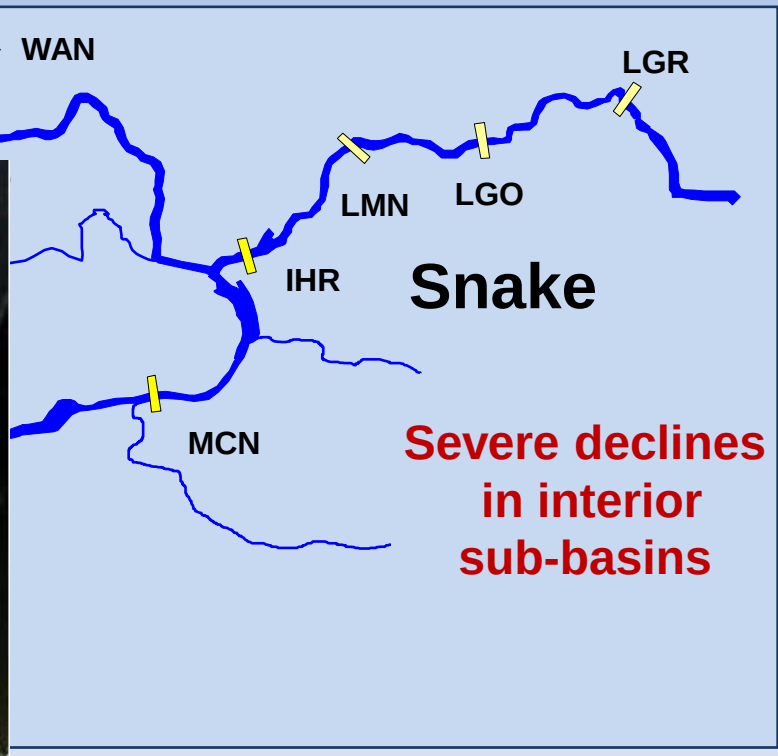
# Pacific lamprey

- Anadromous, panmictic (non-homing)
- Pacific Rim range sympatric with *Oncorhynchus*
- High ecological & cultural value

# Columbia River challenges

- Migration obstacles (dams) associated with widespread decline in lamprey abundance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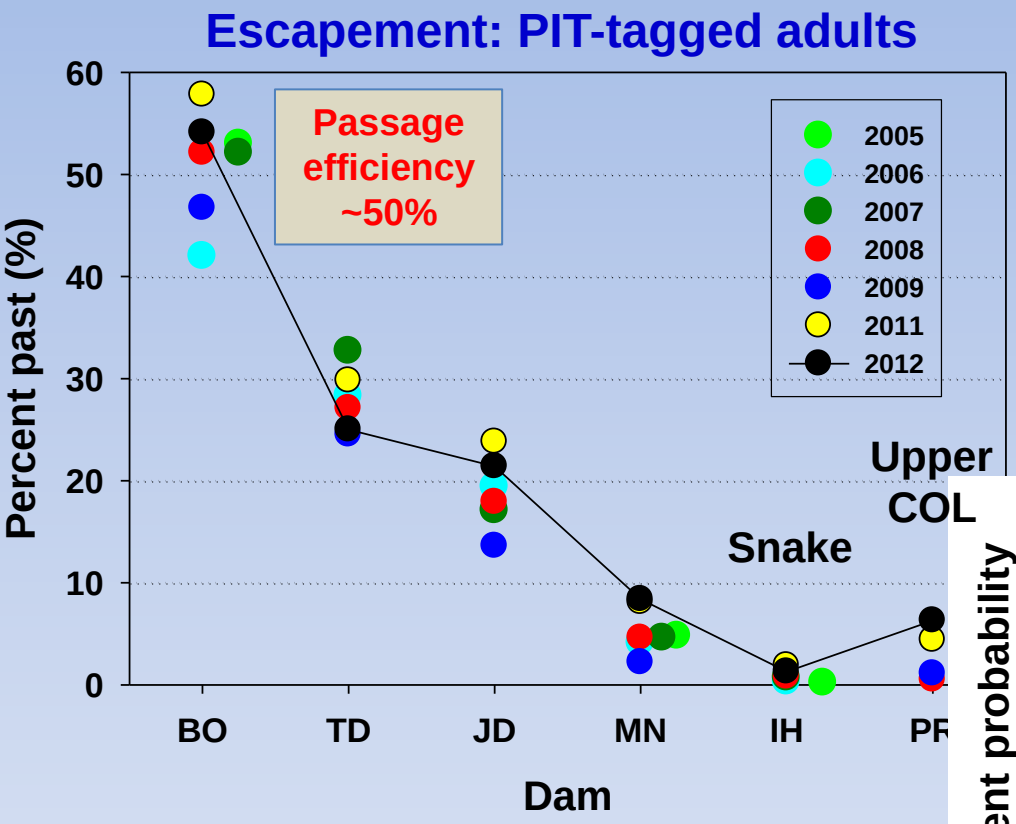
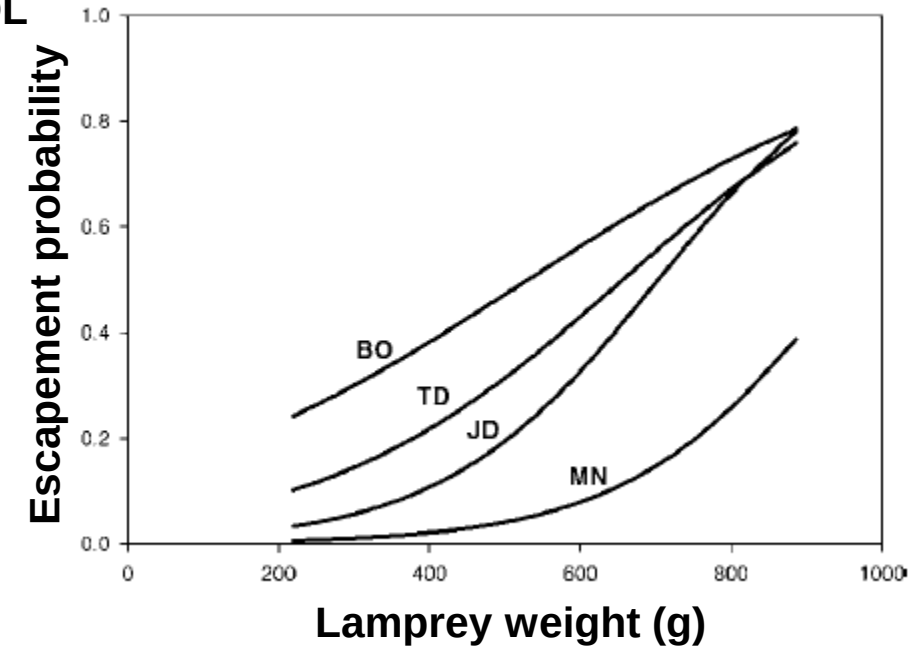
# Adult escapement




**High attrition during Columbia River spawning migration**

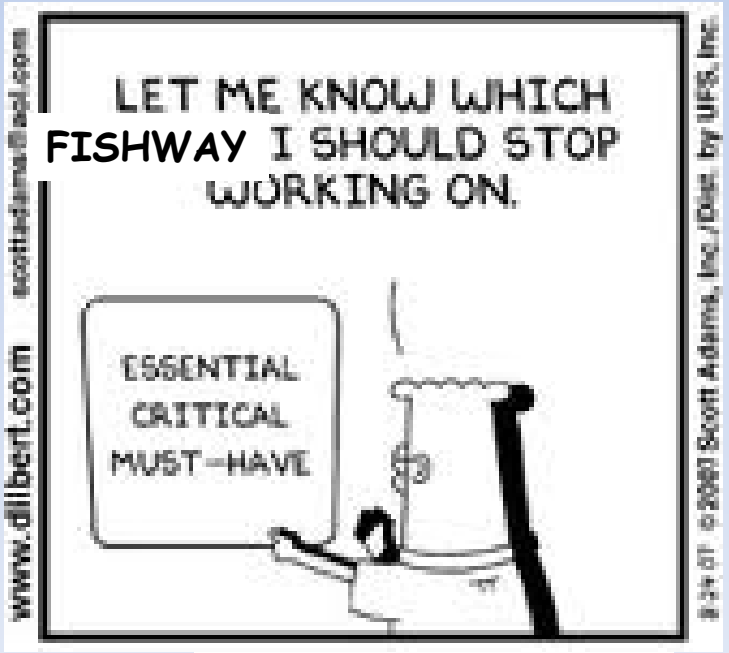
**Size-dependent effect**




Keefer et al. (2009, NAJFM)

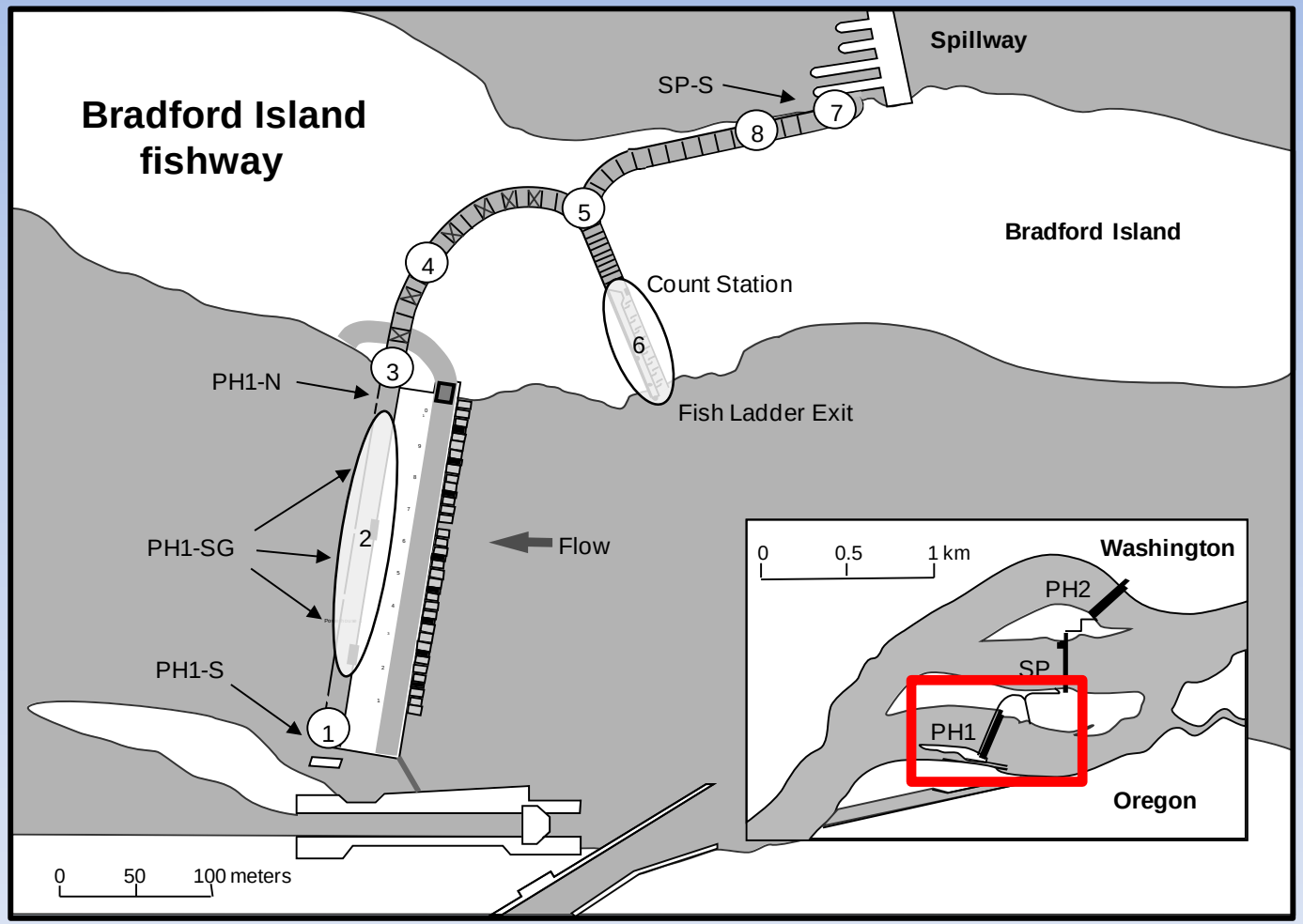
# Presentation objectives

- **Summarize 10 years of adult lamprey radiotelemetry data**
  - **Case study: Bonneville Dam**
- **Identification of passage bottlenecks**
- **Methods / Metric development**
  - **‘Moving bottlenecks’**
  - **Route-related effects**
  - **Accounting for multiple attempts**
- **Recommendations for how to prioritize sites for remediation**
  - **Benefits models**



# Bonneville Dam case study

# Monitoring: Bradford Island fishway




**Damwide: 80 – 100 radio antennas per year**

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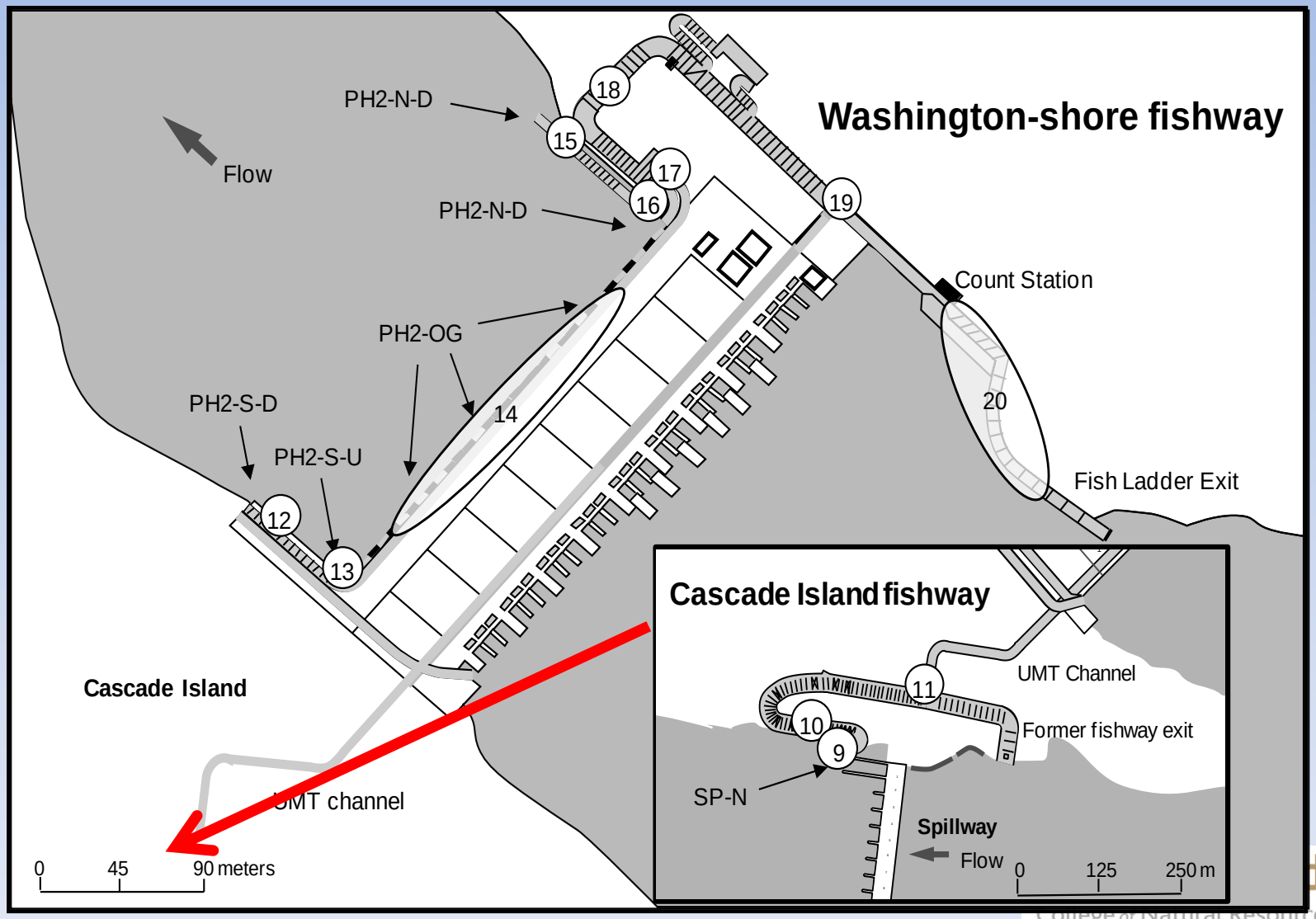
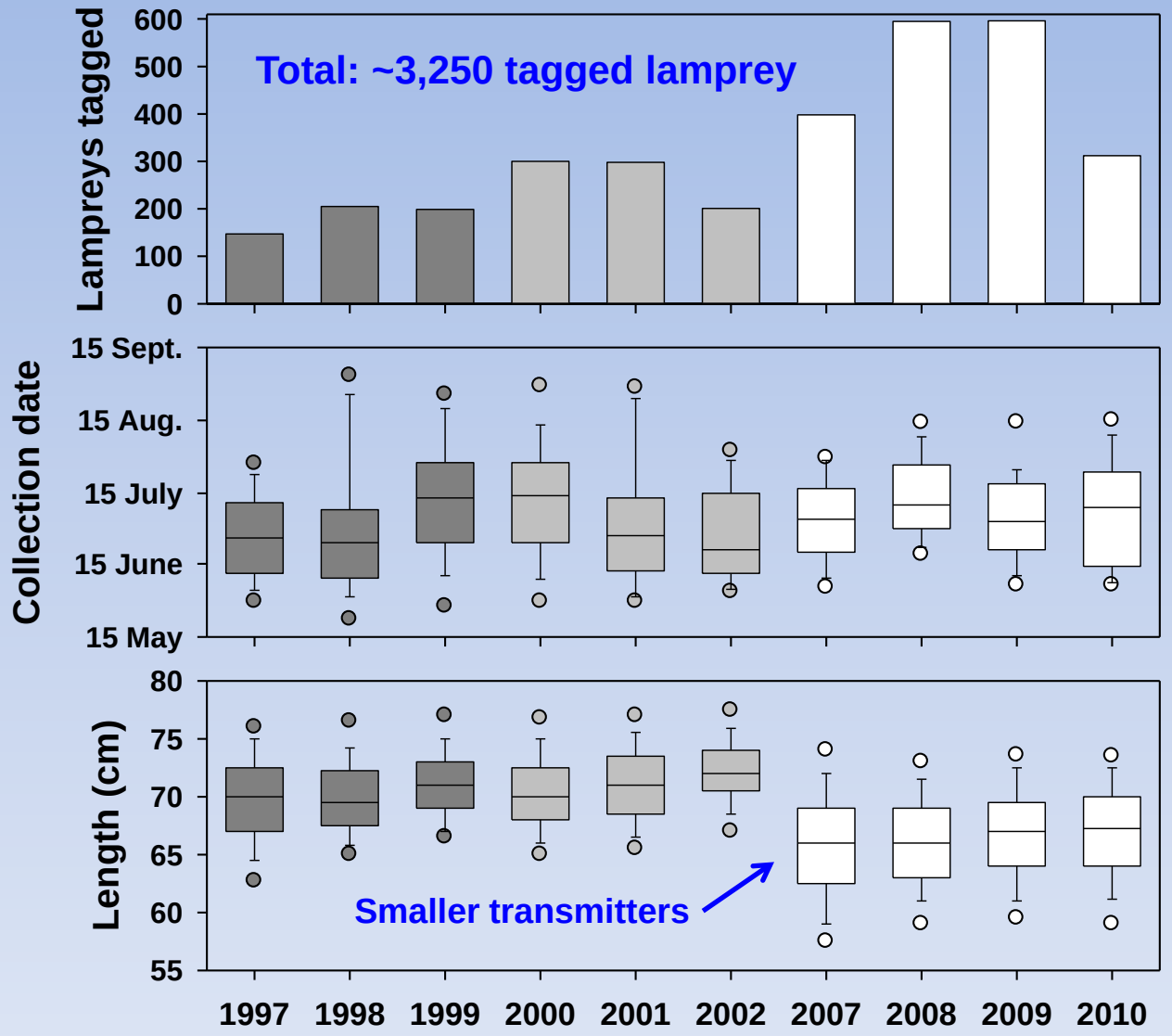
# Monitoring: WA-shore fishway



# Background: Radiotelemetry projects

- **Substantial research effort from 1997-2002, 2007-2010**

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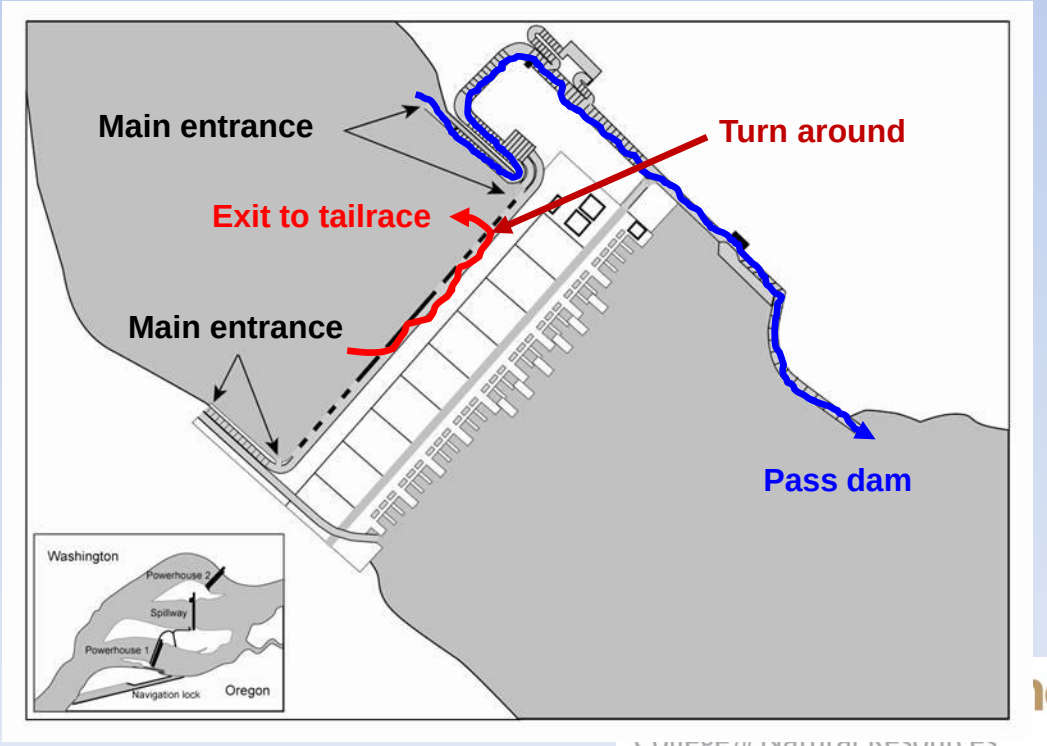
# Data analyses

- **1) Event-based approach**
  - **Assemble all fishway passage attempts, all years**
  - **Score all attempt outcomes: 'Pass dam' or 'Exit to tailrace'**
  - **Infer turn-around location for all exit events**

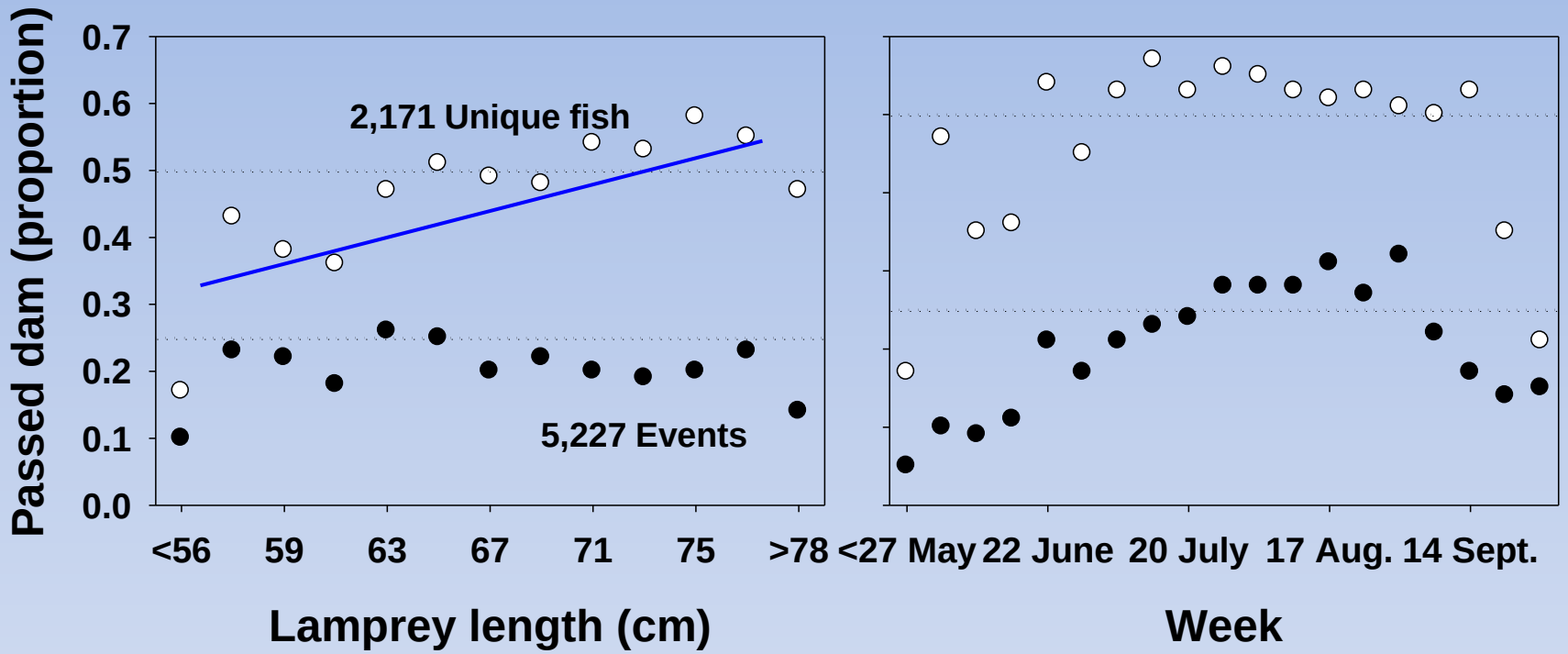
**Events scored: 5227**

- **2) 'Traditional' individual-based approach**
  - **'Passage efficiency'**




Keefer et al. (*in revision*, CJFAS)

# BON passage: events vs. unique fish




- Larger fish more likely to pass
- Larger fish make more attempts

- Clear seasonal effects
- Temperature, tailwater elevation

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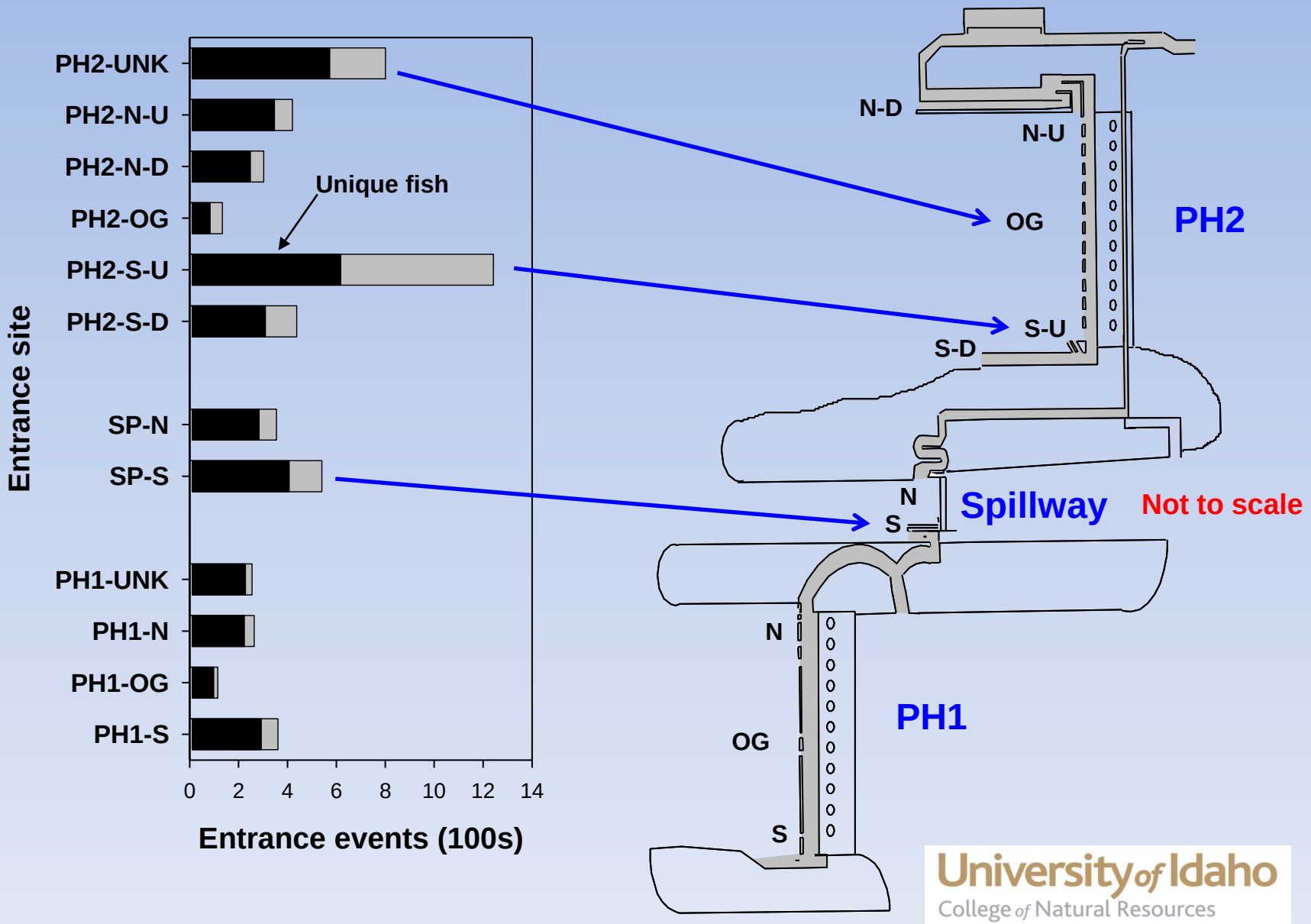
# Route-specific effects

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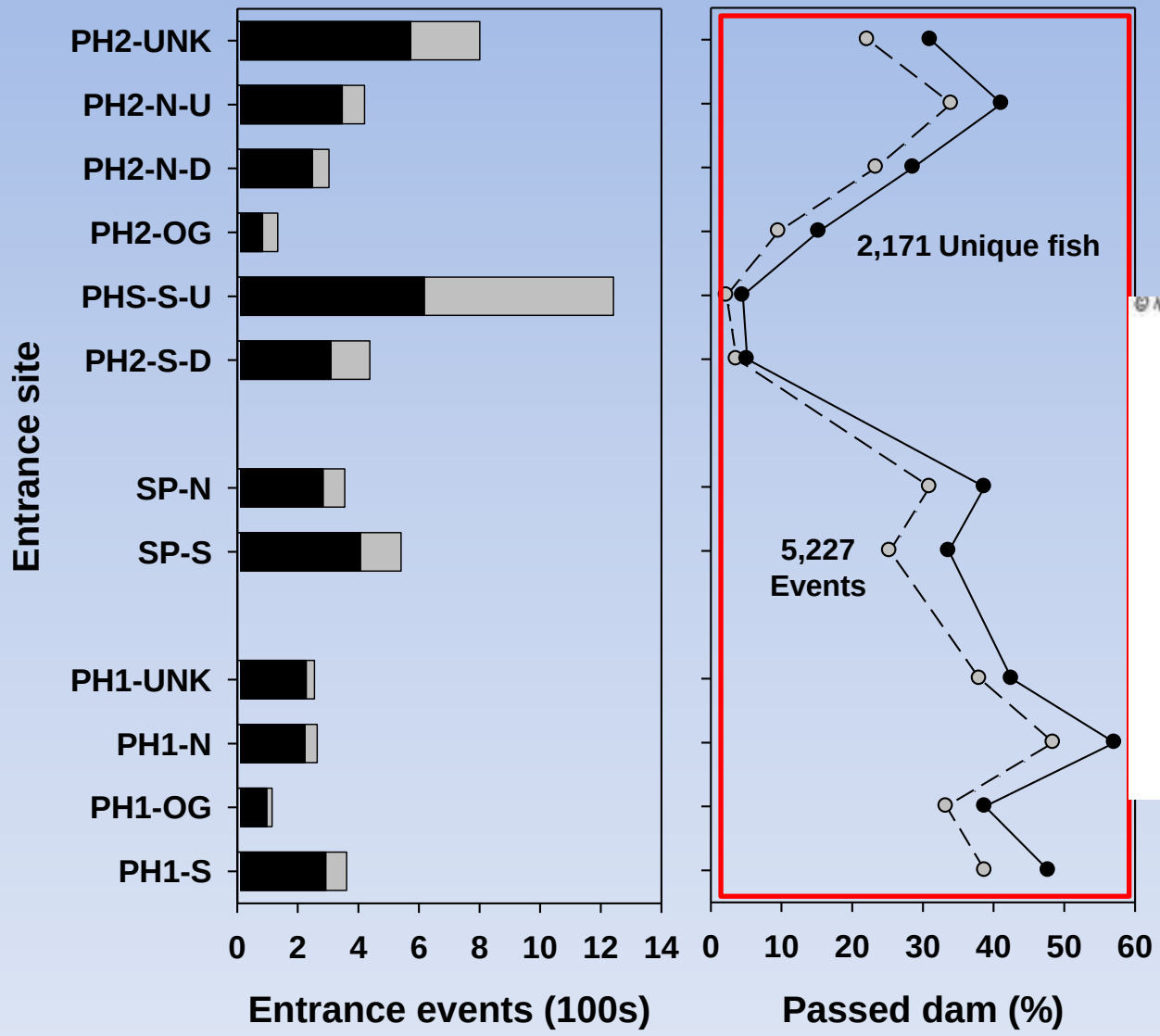
# Route-specific effects




- **Passage *P*'s varied in response to seasonal and time-of-day effects**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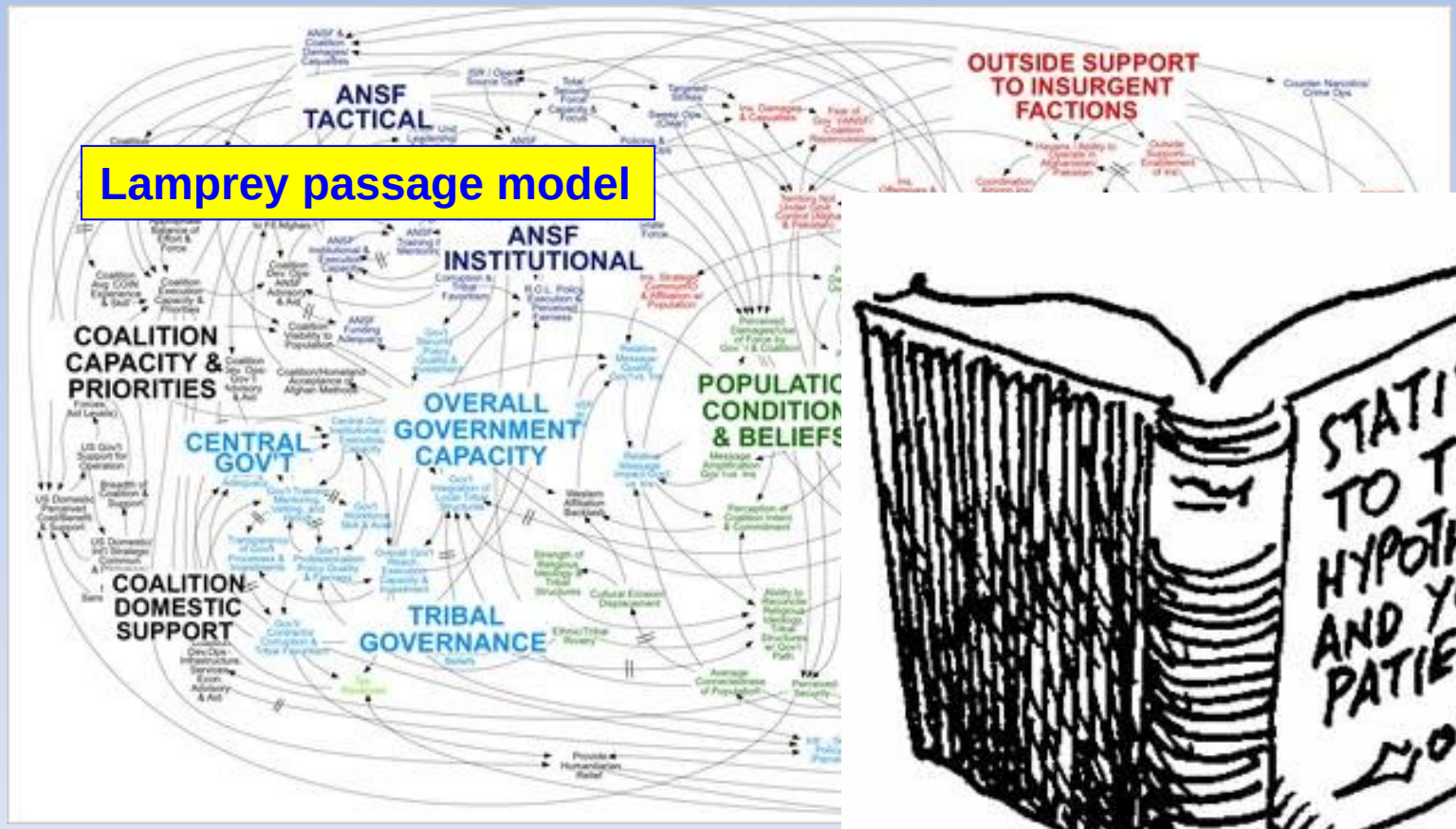
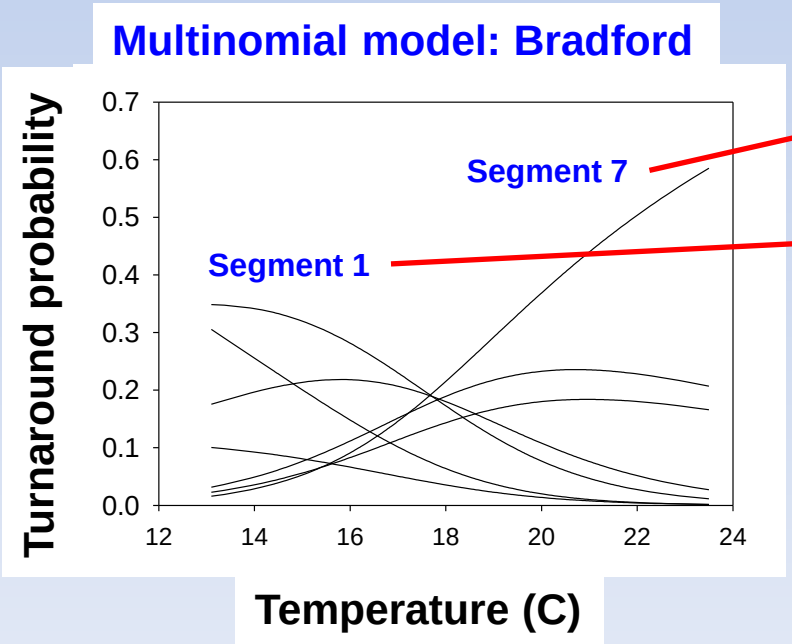
# Where are the bottlenecks and how should we prioritize fixes?

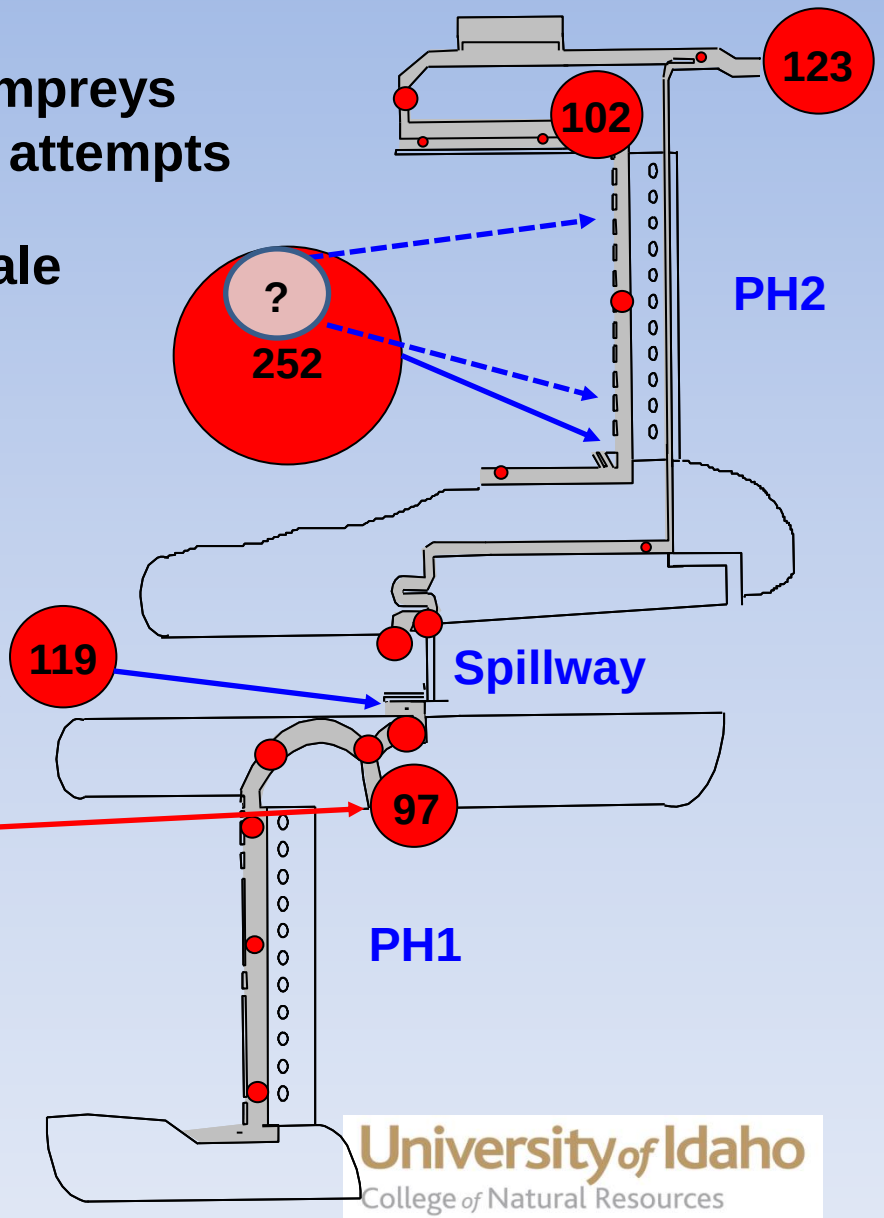


# Bottleneck locations

- **Turn-arounds for 1,071 unique lampreys that made no additional passage attempts**
- **Patterns were similar at event scale**

**Bottleneck locations shifted seasonally – (i.e., 'moving bottlenecks')**

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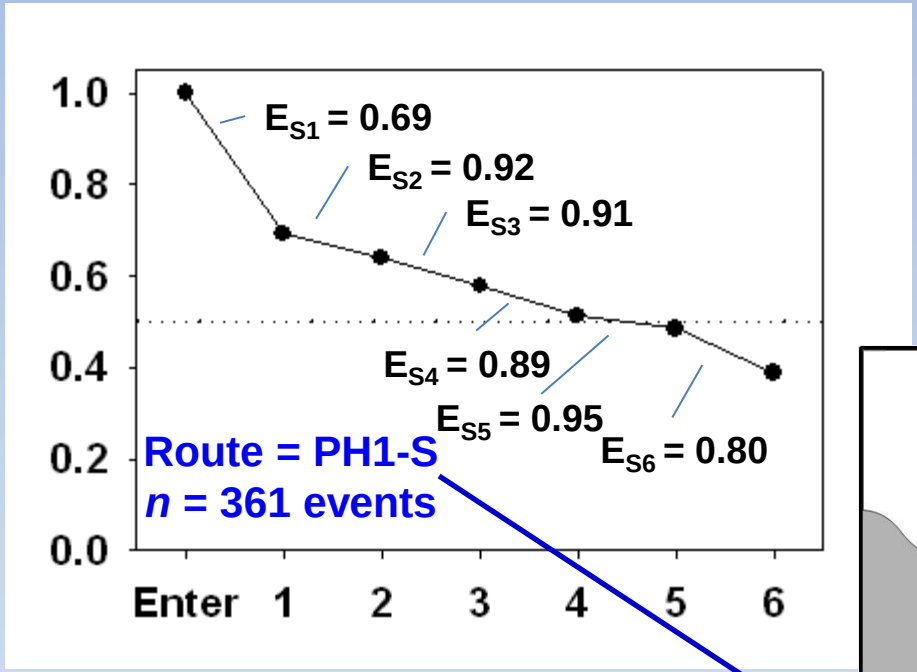
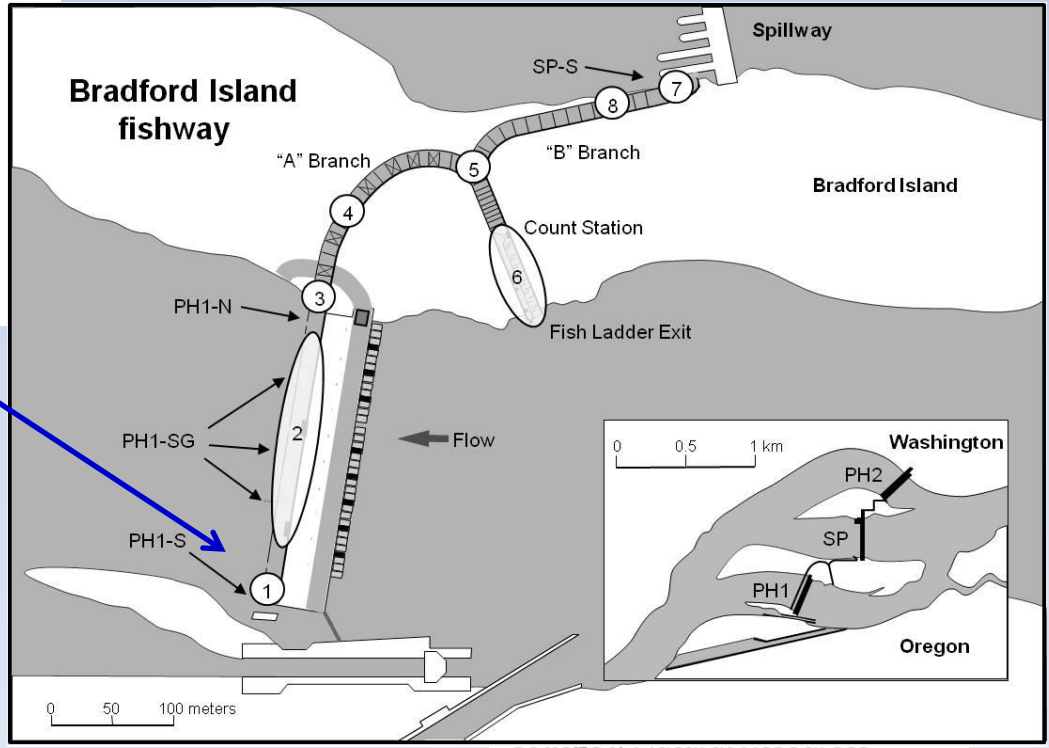
# Benefit prioritization model




**Source data = route×segment efficiency matrix**




**Dam Passage =**
**($N_{events}$×$E_{S1}$×$E_{S2}$×$E_{S3}$×$E_{S4}$×$E_{S5}$×$E_{S6}$)**

**= 141 lamprey past dam**

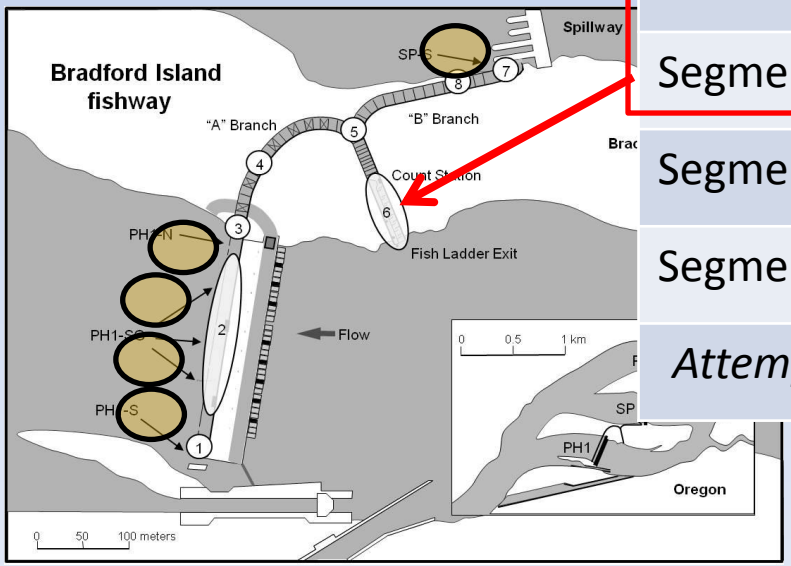
**(Kaplan-Meier survival model)**

# Benefit model methods

**Segment estimates can differ by route**

**Bradford Route×Segment efficiency matrix**

| | PH1-S | PH1-SG | PH1-N | PH1-UNK | SP-S |
|---|---|---|---|---|---|
| Segment 1 | 0.69 | | | 0.96 | |
| Segment 2 | 0.92 | 0.68 | | 0.79 | |
| Segment 3 | 0.91 | 0.74 | 0.77 | 0.77 | |
| Segment 4 | 0.89 | 0.85 | 0.84 | 0.87 | |
| Segment 5 | 0.95 | 0.88 | 0.91 | 0.92 | 0.98 |
| Segment 6 | 0.80 | 0.88 | 0.83 | 0.82 | 0.82 |
| Segment 7 | | | | | 0.51 |
| Segment 8 | | | | | 0.79 |
| *Attempt n* | 361 | 114 | 264 | 255 | 541 |

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# Benefit model methods

## Bonneville model matrix: 12 routes × 20 segments

**1) Increase a segment efficiency ($E_x$) by 10%**

**2) Apply to each route that includes segment**

**3) Recalculate *n* past dam**

**Baseline = 581 past**

**New ($E_6$ ×1.10) = 637 past**

**4) Calculate increase in lamprey passage**

**= (New-Baseline) / Baseline**

**= (637-581) / 581**

**= 9.7% increase**

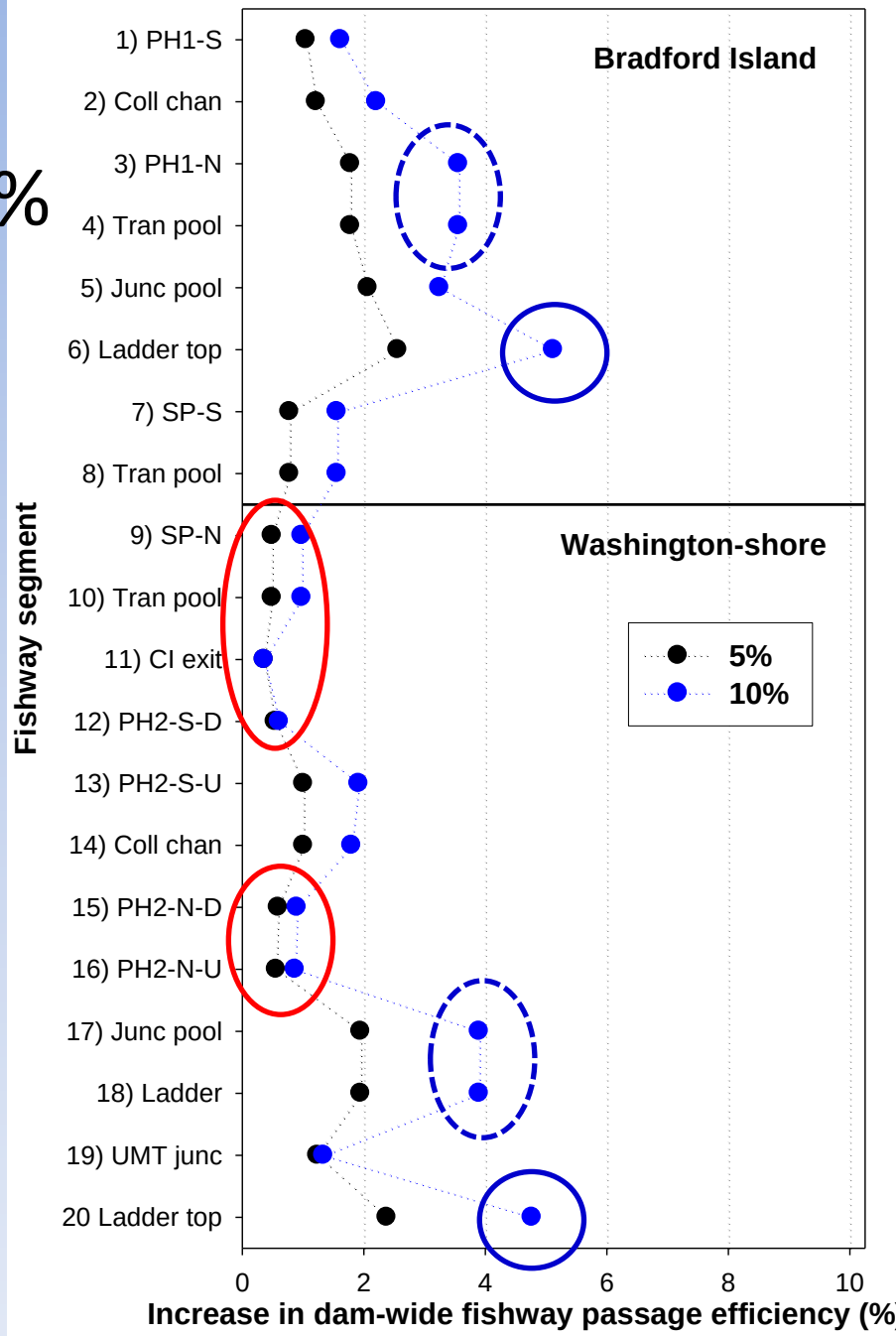
**Bradford Routes**

| | PH1-S | PH1-SG | PH1-N | PH1-UNK | SP-S |
|---|---|---|---|---|---|
| Segment 1 | 0.69 | | | 0.96 | |
| Segment 2 | 0.92 | 0.68 | | 0.79 | |
| Segment 3 | 0.91 | 0.74 | 0.77 | 0.77 | |
| Segment 4 | 0.89 | 0.85 | 0.84 | 0.87 | |
| Segment 5 | 0.95 | 0.88 | 0.91 | 0.92 | 0.98 |
| Segment 6 | 0.80 ×1.10=0.88 | 0.88 ×1.10=0.97 | 0.83 ×1.10=0.91 | 0.82 ×1.10=0.90 | 0.82 ×1.10=0.90 |
| Segment 7 | | | | | 0.51 |
| Segment 8 | | | | | 0.79 |
| *Attempt n* | 361 | 114 | 264 | 255 | 541 |

# Bonneville results

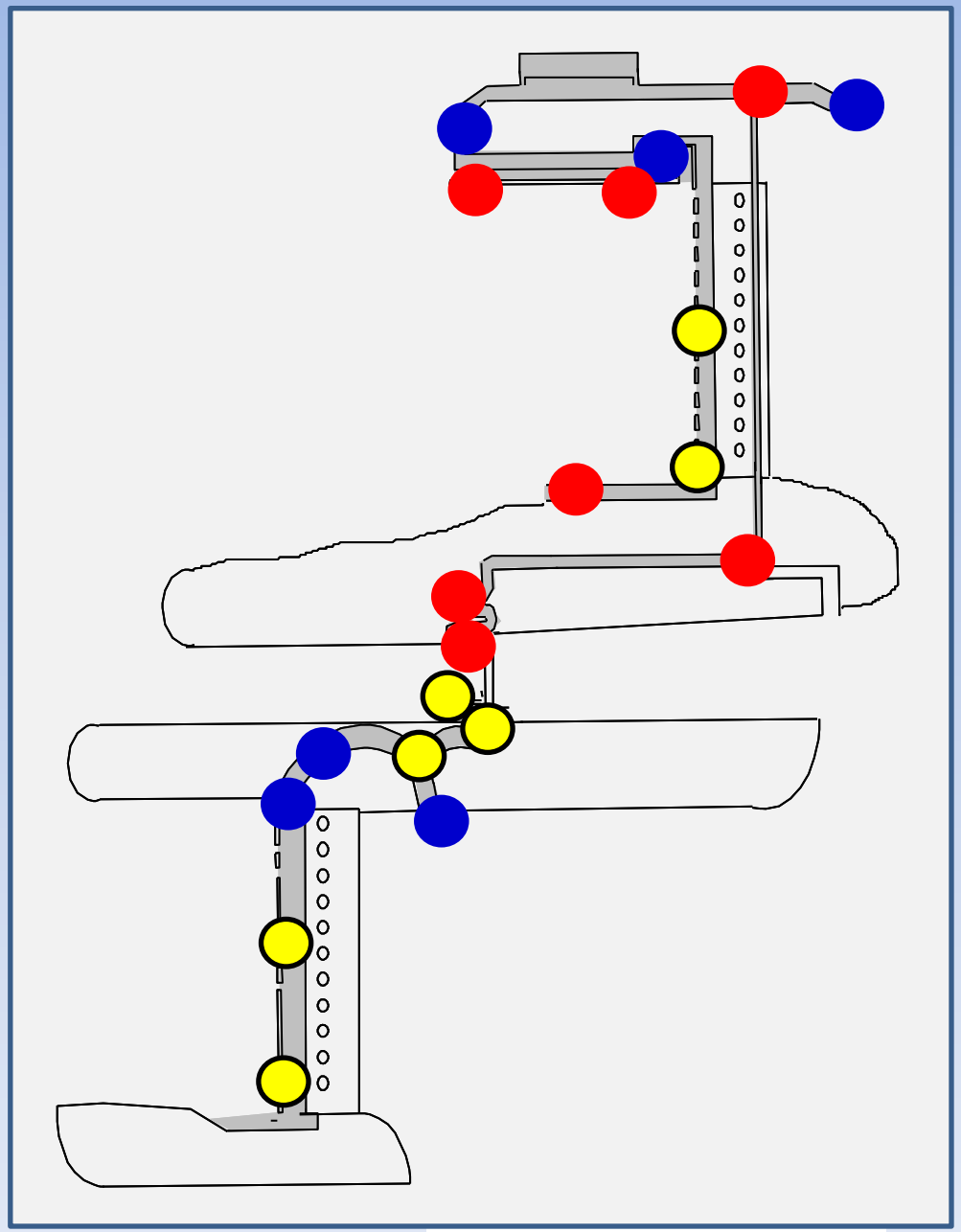
- 40K Simulations +5%, +10%
- Highest benefits
- Lowest benefits


Segment 17: Junction pool



# Bonneville results

- High benefit sites
  - Many lamprey
  - Convergent routes
  - Sufficient ‘Scope for improvement’
- Low benefit sites
  - Few lamprey (CI)
  - Limited ‘scope for improvement’ (UMT)
  - Serious bottlenecks upstream



# Conclusions

- Pacific lamprey passage challenges: substantial & complex
- Long-term, adaptive research and monitoring program has yielded many insights
- US Army Corps, Public Utility Districts, and partners have made many fishway improvements
- New analytical tools that can be broadly applied
  - Individual- and Event-based models & metrics
  - Bottleneck Identification & 'Benefits' models

# Questions?

Jeremy Red Star Wolf, Umatilla Tribe

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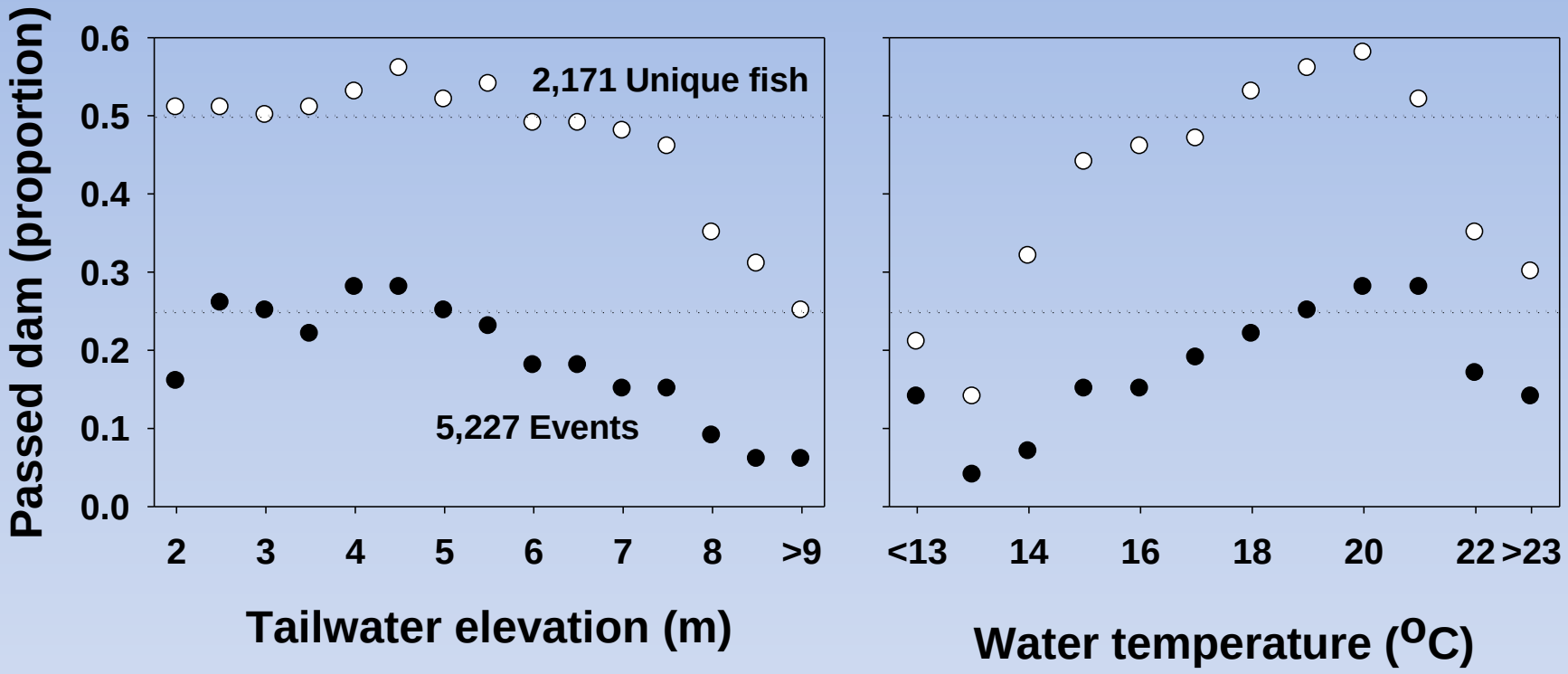
# BON passage: events vs. unique fish




- **Low passage success under high tailwater conditions**
- **Seasonal / temperature effect**

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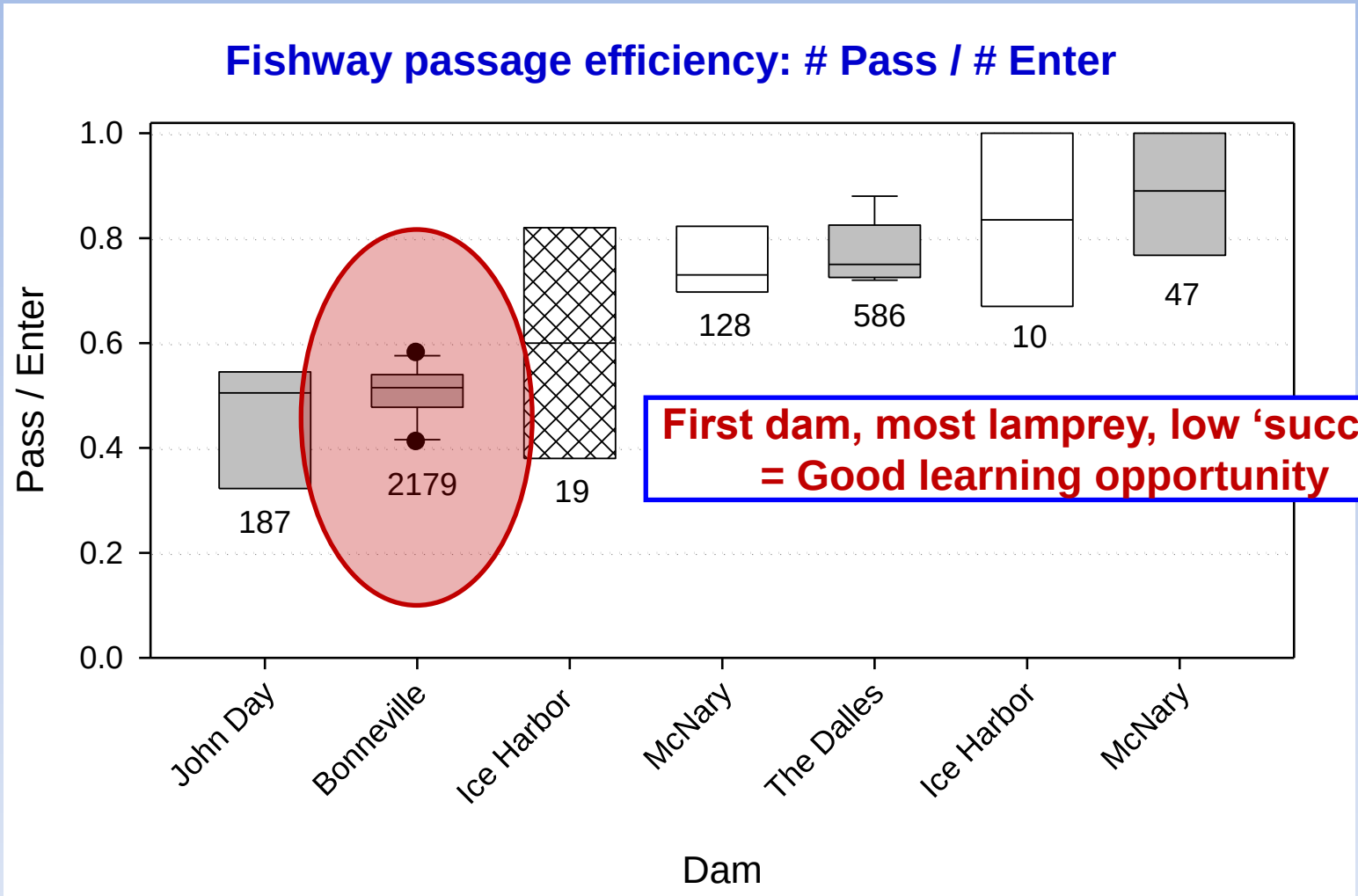
# What is the dam problem?

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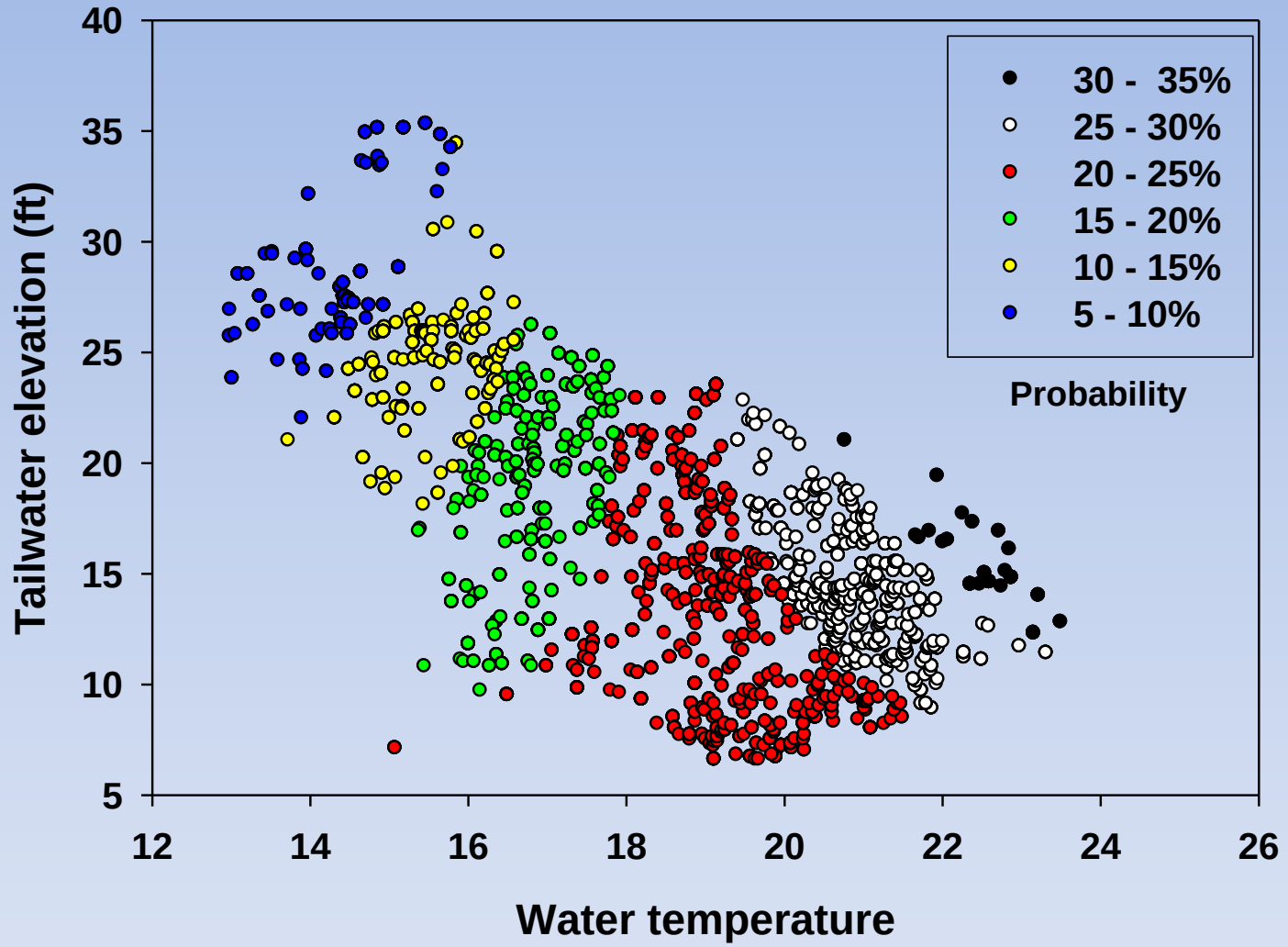
# BON passage probability




**Logistic model: Pass (0,1) = Elev + Temp + Elev×Temp**

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